In re application of	:	Hampapur, et al.
App. No.	:	08/870,836
Filed	:	June 6, 1997
For	:	KEY FRAME SELECTION
Examiner	:	Anand Rao
Art Unit	:	2713

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July 27, 1999
(Date)

John M. Carson, Reg. No. 34,303

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

Sir:

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated as shown below:

CLAIMS AS FILED

	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NO. PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE
Total Claims	22	MINUS	22	= 0 ×	$18	= $0
Independent Claims	3	MINUS	3	= 0 ×	$78	= $0
If application has been amended to contain multiple dependent claim(s), then add					$260	= $0
Time Extension Fee						$0
				TOTAL ADDITIONAL FEE FOR THIS AMENDMENT		$0

Enclosed are:

(X) Return prepaid postcard.

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John M. Carson
Registration No. 34,303
Attorney of Record

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KNOBBE, MARTENS, OLSON & BEAR, LLP
620 NEWPORT CENTER DR 16TH FLOOR NEWPORT BEACH, CA 92660
(949) 760-0404 FAX (949) 760-9502

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Hampapur, et al.	Group Art Unit 2713
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AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In response to the Office Action dated April 28, 1999 (Paper No. 5) in the above-referenced patent application, please make the following amendments:

IN THE SPECIFICATION:

On page 4, line 14, **please delete** "chromatic" **and substitute therefor** --structural--.

On page 15, line 12, **please delete** "δx" **and substitute therefor** --x--.

On page 15, line 14, **please delete** "Δy" **and substitute therefor** --δy--.

IN THE CLAIMS:

Please amend the following claims:

1. (Amended) A computerized method of extracting a key frame from a video, comprising **[the steps of]**:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a chromatic difference measure between the reference frame and the current frame;

d) determining a structure difference measure between the reference frame and the current frame; and

e) identifying the current frame as a key frame if the chromatic difference measure exceeds a chromatic threshold and the structure difference measure exceeds a structure threshold.

2. (Amended) The method defined in Claim 1, additionally comprising **[the step of]** setting the current frame to be the reference frame if a key frame is identified.

3. (Amended) The method defined in Claim 1, additionally comprising **[the step of]** repeating **[steps c-e]** c)-e) for a new current frame until the end of the video is reached.

7. (Amended) The method defined in Claim 1, wherein **[the step of]** determining the structure difference measure is performed only if the chromatic difference measure exceeds the chromatic threshold.

8. (Amended) A computerized method of extracting a key frame from a video having a plurality of frames, the method comprising **[the steps of]**:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a first difference measure between the reference frame and the current frame;

d) determining a second difference measure between the reference frame and the current frame; and

e) identifying the current frame as a key frame if the first difference measure exceeds a first threshold and the second difference measure exceeds a second threshold.

9. (Amended) The method defined in Claim 8, additionally comprising **[the step of]** setting the current frame to be the reference frame if a key frame is identified.

11. (Amended) The method defined in Claim 8, additionally comprising **[the step of]** repeating **[steps c-e]** c)-e) for a new current frame until the end of the video is reached.

14. (Amended) The method defined in Claim 8, wherein **[the step of]** determining the second difference measure is performed only if the first difference measure exceeds the first threshold.

17. (Amended) The method defined in Claim 8, additionally comprising **[the step of]** determining a third difference measure between the reference frame and the current frame, and wherein the identifying **[step]** identifies the current frame as the key frame if the third difference measure exceeds a third threshold.

18. (Amended) A computerized method of extracting a key frame from a video having a plurality of frames, the method comprising **[the steps of]**:

a) providing a reference frame;

b) providing a current frame different from the reference frame;

c) determining a structure difference measure between the reference frame and the current frame; and

d) identifying the current frame as a key frame if the structure difference measure exceeds a structure threshold.

19. (Amended) The method defined in Claim 18, additionally comprising **[the step of]** setting the current frame to be the reference frame if a key frame is identified.

20. (Amended) The method defined in Claim 18, additionally comprising **[the step of]** repeating **[steps c and d]** c) and d) for a new current frame until the end of the video is reached.

REMARKS

Applicant amends the specification and Claims 1, 2, 3, 7, 8, 9, 11, 14, 17, 18, 19, 20 by this paper. Claims 4-6, 10, 12-13, 15-16 and 21-22 remain unchanged and are presented for examination. Reconsideration and allowance of all Claims 1-22 in light of the present remarks is respectfully requested.

Applicant has corrected clerical errors on pages 4 and 15 of the specification, and has made clarifying amendments to the claims by removing the term "steps" to avoid any triggering of the application of §112, ¶6 to these method claims.

Discussion of the Claim Rejection under 35 U.S.C. § 102(e)

Claims 1-22 were rejected under 35 U.S.C. § 102(e) as being anticipated by Zhang et al. ("Zhang"), U.S. Patent No. 5,635,982. The Zhang patent reference describes three algorithms or methods: (1) a method of segmenting a video sequence of frames into individual camera shots by determining segment boundaries (shot segmentation); (2) a method of automatically selecting threshold values for use in determining segment boundaries, particularly the shot break threshold and the transition break threshold; and (3) a method of key frame selection from a sequence of frames. The first algorithm is described at Column 4, line 62 to Column 6, line 63; the second algorithm is described at Column 6, line 65 to Column 7, line 28; and the third algorithm is described at Column 7, lines 30-62. The key frame selection algorithm solves an entirely different problem than the segmentation algorithm.

Applicant describes the prior techniques, including Zhang, at page 3 of the specification:

> Most existing techniques have focused on detecting abrupt and gradual scene transitions in video. However, the more essential problem to be solved is deriving an adequate visual representation of the visual content of the video.
>
> Most of the existing scene transition detection techniques, including Shahraray and Zhang et al., use the following measurements for gradual and abrupt scene transitions: 1) Intensity based difference measurements wherein the difference between two frames from the video which are separated by some time interval "T", is extracted. Typically, the difference measures include pixel difference measures, gray level global histogram measures, local pixel and histogram difference measures, color histogram measures, and so forth. 2) Thresholding of difference measurements wherein the difference measures are thresholded using either a single threshold or multiple thresholds.
>
> However, to generate an adequate visual representation of the visual content of the video, a system is needed wherein the efficacy of the existing techniques is not critically dependent on the threshold or decision criteria used to declare a scene

> break or scene transition. Using existing techniques, a low value of the threshold would result in a oversampled representation of the video, whereas, a higher value would result in the loss of information. What is needed is a system wherein the choice of the decision criteria is a non-critical factor.

In particular, the Zhang patent describes use of several difference metrics at Column 3, line 18 to Column 4, line 18: pair-wise pixel comparison, likelihood ratio, histogram comparison, and χ^2 test. The first two metrics, pair-wise pixel comparison and likelihood ratio, utilize the intensity values of the pixels in successive frames. The histogram comparison "is less sensitive to object motion, since it **ignores the spatial changes in a frame.**" "The χ^2 test is a modified version of" the histogram comparison "which makes the histogram comparison reflect the difference between two frames more strongly." (emphasis added).

Applicant claims a computerized method of extracting a key frame from a video. Applicant may utilize a two stage key frame extraction process, as claimed in Claim 1:

> determining a chromatic difference measure between the reference frame and the current frame; determining a structural difference measure between the reference frame and the current frame; and identifying the current frame as a key frame if the chromatic difference measure exceeds a chromatic threshold and the structure difference measure exceeds a structure threshold.

In this process, determining the structure difference measure may be performed only if the chromatic difference measure exceeds the chromatic threshold. The chromatic measurements filter the video based on the brightness and color differences between frames, for example. The structural difference measurement compares images based on the structure or edge content of the image. Zhang does not utilize structural difference measurements. In fact, Zhang teaches away from structural difference measurements at Column 7, lines 52-61:

> The key frame extraction method as described in FIG. 4 is different from prior art. Prior art used motion analysis which depends heavily on tracing the *positions and sizes of the objects* being investigated using mathematical functions to extract a key frame. This method is not only too slow but also impractical ... the present invention extracts key frames purely based on the temporal variation of the video content as described in FIGS. 4 and 4A. (emphasis added)

Therefore, since the above excerpt differentiates the temporal variation from tracking "the positions and sizes of objects being investigated" in the frames, the temporal variation is not referring to structural differences, but rather, must be referring to the only difference metrics

described in the patent. These are the difference metrics described in Columns 3-4, which measure intensity differences. For example, recall that Column 4 recites a description of one of the difference metrics as follows: "Histogram comparison ... ignores the spatial changes in a frame."

The combination of measuring two or more orthogonal image features in a hierarchical manner is also not shown in Zhang. As explained on page 2 of Applicant's specification, two frames may be compared based on several different sets of image properties, such as color properties, distribution of color over the image space, structural properties, and so forth. Since each image property represents only one aspect of the complete image, a system for generating an adequate representation by extracting orthogonal properties from the video is described by Applicant.

While operating on a typical produced video, such as a television feed, the chromatic difference measurement may be tuned to pick up frames during gradual transitions, such as fades, dissolves, wipes and so forth. These frames are typically chromatically different but structurally similar. The redundancy in the output of the chromatic difference based measurement is filtered out by the structural difference measurement to then yield the actual keyframes. For example, frames in a fade have the same structure, but are significantly different chromatically due to the fading effect.

Thus, the combination of measuring two or more orthogonal image features in a hierarchical manner provides a significant improvement in generating an adequate representation of the video while keeping the computational process simple and efficient. The first feature measurement (e.g., chromatic difference) is selected to be computationally cheaper than the second measure. The second feature measurement (e.g., structural difference) is a more discriminatory measurement that extracts more information from a frame than the first measure. Applicant's hierarchical method can be extended to "N" stages or measures.

Applicant's definition for key frame extraction at Claims 6 and 13 includes the following: "the value of the first threshold and the value of the second threshold are each user-selectable." The Examiner stated that Zhang, at Column 7, lines 1-29, discloses that the first and second thresholds are user selectable. This cited passage describes automatically determining threshold values used for determining segment boundaries in the segmentation algorithm. The text describes how the shot break threshold is *automatically computed* based on statistics, and how

the transition break threshold is based on an equation that includes the computed shot break threshold. Thus, Zhang does not disclose a user-selectable chromatic threshold and a structure threshold for extracting a key frame.

Applicant's definition for key frame extraction at Claims 7 and 14 includes the following: "the structure difference measure is performed only if the chromatic difference measure exceeds the chromatic threshold." The second of the two unique difference measurements is performed if the result of the first difference measurement exceeds its threshold. The Examiner stated that Zhang, at Column 6, lines 30-40, discloses that determining the structure difference measure is performed only if the chromatic difference measure exceeds the chromatic threshold. This cited passage describes a method of skipping a preselected number of frames (skip factor S) to determine potential segment boundaries in the *segmentation algorithm*, which has nothing to do with key frame selection. Thus, Zhang does not disclose performing the structure difference measure to extract key frames only if the chromatic difference measure exceeds the chromatic threshold.

Applicant's definition for key frame extraction at Claim 10 includes the following: "the first difference measure is orthogonal to the second difference measure." The combination of measuring two or more orthogonal image features in a hierarchical manner is not disclosed in Zhang. Orthogonal image properties are not even discussed in Zhang. The Examiner apparently incorrectly grouped Claim 10 with the rejection of Claim 3, which concerns repeating for a new frame.

Applicant's definition for key frame extraction at Claims 15 and 16 includes the following: "the second difference measure is computationally more expensive than the first difference measure" and "the second difference measure extracts more information than the first difference measure". The Examiner stated that Zhang, at Column 7, lines 1-60, discloses that the second difference measurement is more computationally intensive and extracts more information than the first difference measure. Lines 1-28 of the cited passage describe the second algorithm of the invention of automatically selecting threshold values for use in determining segment boundaries. The remainder of the cited text describes the third algorithm on key frame selection wherein a selected difference metric is used. The Zhang patent does not, however, describe that two unique metrics are used. Moreover, even if two unique metrics would be used in the key frame algorithm, the Zhang patent does not describe that the second metric is more computationally intensive and extracts more information than the first metric.

Applicant's definition for key frame extraction at Claim 17 includes the following: "determining a third difference measure between the reference frame and the current frame, and wherein the identifying identifies the current frame as the key frame if the third difference measure exceeds a third threshold." The Examiner stated that Zhang, at Column 3, lines 45-68, discloses using a third difference measure. This cited passage in Zhang does identify one of the difference metrics. However, the Zhang reference does not disclose using more than one difference measure for key frame selection.

Applicant submits that Zhang is overcome as a reference for Claims 1, 8 and 18. Since Claims 2-7, 9-17 and 19-22 are dependent on independent Claims 1, 8 and 18, respectively, pursuant to 35 U.S.C. § 112, ¶4, they incorporate by reference all the limitations of the claim to which they refer. Therefore, the rejection of the dependent Claims 2-7, 9-17 and 19-22 has also been overcome. Therefore, in view of the above, it is submitted that Claims 1-22 are clearly distinguished from the cited art and are patentable.

Conclusion

By this amendment, Applicant has amended the specification and claims. In view of the foregoing amendments and remarks, Applicant respectfully submits that Claims 1-22 of the above-identified application are in condition for allowance. However, if the Examiner finds any further impediment to allowing all claims that can be resolved by telephone, the Examiner is respectfully requested to call the undersigned.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: 7/27/99

By: _____

John M. Carson
Registration No. 34,303
Attorney of Record
620 Newport Center Drive
Sixteenth Floor
Newport Beach, CA 92660
(619) 235-8550

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